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The Effect of Georgia's HOPE Scholarship on College Major: A Focus on STEM

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THE EFFECT OF GEORGIA'S HOPE SCHOLARSHIP ON COLLEGE MAJOR: A FOCUS ON STEM*

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Abstract

There is growing concern in the U.S. that the nation is producing too few college graduates in science, technology, engineering, and mathematics (STEM) fields and there is a desire to understand how various policies affect college major decisions. This paper uses student administrative records from the University System of Georgia to examine whether Georgia's HOPE Scholarship has affected students' college major decisions, with a focus on STEM majors. We find consistent evidence that HOPE reduced the likelihood that a USG student earned a degree with a major in a STEM field. We discuss and test a number of explanations for why this occurred.

JEL Codes: I23, J24
Keywords: merit aid; HOPE Scholarship; college major; STEM

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I. Introduction

State merit aid programs have grown substantially since the early 1990s, with Georgia's HOPE Scholarship program adopted in 1993 being among the largest and most notable. A large research literature has emerged that examines the various effects of these merit aid programs on college outcomes such as enrollment, persistence, completion, and post-college retention in the state. One outcome receiving limited attention thus far is the effect of merit aid on college major decisions.[1] This paper examines the effect of Georgia's HOPE Scholarship program on students' college major choices using administrative records from the University System of Georgia. We focus on the effects of HOPE on degrees in the fields of science, technology, engineering, and mathematics (STEM).

Understanding how college majors are affected by merit-based financial aid is important for two main reasons. First, an individual's college major has a substantial impact on post-college earnings and STEM graduates have considerably higher average earnings than non-STEM graduates (Arcidiacono 2004; Sjoquist and Winters 2013). Second, researchers and policymakers are concerned that the U.S. is producing too few college graduates majoring in STEM fields (National Academies 2010). STEM fields are widely considered to be important drivers of technological innovation (Atkinson and Mayo 2010). If the nation produces too few STEM graduates, it could reduce U.S. international competitiveness, constrain long run economic growth, and reduce individual well-being. Furthermore, particularly states may experience especially severe STEM shortages that hinder their economic development efforts. Understanding how education policies, such as Georgia's HOPE Scholarship, affect student

[1] In a related paper, Sjoquist and Winters (2013) use American Community Survey microdata to examine the average effects of merit aid programs across 25 states adopting them since 1991. The analysis focuses on nine states with relatively large and generous merit aid programs, and they find that the merit programs in these states substantially reduced the likelihood that an individual earned a degree in a STEM field. The current paper and Sjoquist and Winters (2013) were initially one paper but have been separated into two papers.

decisions to major in STEM fields has important consequences for individual states and the nation.

We identified only two other studies that examined the effects of state merit aid programs on college majors. Cornwell, Lee, and Mustard (2008) investigate the effect of Georgia's HOPE Scholarship on the college major choices of freshmen enrolled at the University of Georgia. They find that HOPE significantly increased the probability of majoring in education but find no significant effect of HOPE on other majors. Our administrative data includes all 35 public colleges and universities in Georgia, not just one university as with Cornwell, Lee, and Mustard (2008). Furthermore, we consider both freshman major and the major upon graduation.

Zhang (2011) examines the effects of merit aid programs in Florida and Georgia on annual statewide STEM degree conferrals computed from the Integrated Postsecondary Education Data System's (IPEDS) Completion Survey. He generally finds statistically insignificant effects of merit aid on the percentage of STEM graduate in each state, with the one exception being a 1.6 percentage point increase for Florida private institutions. However, merit aid programs likely affect where students attend college and have been shown to increase the average academic ability of students in the state. STEM fields require greater academic ability, especially in math, so merit-induced increases in average student quality need to be accounted for, but using aggregate data prevents Zhang from doing so.

We examine the effects of Georgia's HOPE Scholarship on students' college major decisions, focusing specifically on whether they major in STEM fields, using administrative data for the University System of Georgia (USG). Our analysis accounts for merit-aid induced changes in student academic quality by directly controlling for SAT scores and high school attended, as well as sex, race, and ethnicity.

To preview our results, we find consistent evidence that Georgia's HOPE Scholarship reduced the probability that a young person would complete a bachelor's degree with a major in a STEM field. Our baseline specification yields an estimate of a 12.9 percent decrease in the number of STEM graduates, with the effects being larger for males than females. The USG data include detailed student information that allows us to take a closer look at which students are shifting away from STEM. We estimated the effect by ability and found that the relative effects were most pronounced for students with good but unexceptional math skills. Our data do not allow us to identify the exact mechanisms driving the negative results, but we do offer some important insights. The decrease in STEM degrees in Georgia appears to be driven largely by the decreased likelihood that initial STEM majors actually go on to earn a STEM degree; HOPE did not significantly affect the likelihood that a student chooses STEM as their initial major. However, HOPE did affect enrollment decisions and appears to have caused a given quality student to enroll in an institution in which they are less likely to earn a STEM degree. We also find evidence that HOPE encouraged students to take actions to increase their GPAs in order to retain HOPE.

II. Data and Empirical Framework

We explore the effects of the Georgia HOPE Scholarship on college major using administrative data for the University System of Georgia (USG). The USG is a statewide system that at the time consisted of 35 public higher education institutions including two- and four-year colleges and universities in Georgia. From the USG Board of Regents we obtained data on four cohorts of entering students to the USG. The four cohorts include all students who graduated from a Georgia high school during the years 1990, 1991, 1995 and 1996 and enrolled in a USG institution in the same year (i.e., students who enrolled in the summer or fall terms immediately after graduating high school). Data were obtained for the 1995 and 1996 cohorts instead of the 1993 and 1994 cohorts because these first two post-HOPE cohorts were initially subject to an income cap for eligibility. The 1992 cohort of students was avoided out of concern that some of these students might have anticipated the passage of HOPE and altered their behavior in response. The 1990-1991 cohorts are therefore the pre-HOPE control group and the 1995-1996 cohorts are the post-HOPE treatment group.

The USG sample is also restricted to Georgia residents who graduated high school in Georgia because non-residents and graduates of schools outside of Georgia were not eligible for HOPE. Of particular importance, we know the major declared as a freshman and the earned major upon graduation. We first consider the effect of HOPE on majoring in a STEM field, and then consider the effects on other broad majors. Descriptive statistics are present in Table 1.

We estimate a linear probability model as follows:

$$P(Y_{it} = 1) = \beta X_{it} + \theta PostHOPE_t + \varepsilon_{it},$$

where Y is an indicator variable equal to one if the individual's major is in a STEM field, X includes dummy variables for sex, race, Hispanic origin, high school attended, SAT score, and high school GPA, and $PostHOPE$ is a dummy equal to one for the 1995-96 cohorts and zero for the 1990-91 cohorts.[2] Therefore, θ measures the effect of the HOPE program on the probability of being a STEM major holding student quality and demographics constant. We consider both the major at time of matriculation (initial major) and the final major (earned major) for students

[2] Note that the $PostHOPE$ dummy equals one for all students in the post-HOPE cohort and not just students who received the HOPE Scholarship. We do not have the HOPE GPA needed to determine if pre-HOPE students would have qualified for HOPE had it existed. However, 86 percent of our post-HOPE sample of graduates received HOPE as freshmen as did 92 percent of post-HOPE graduates with initial STEM majors, so the post-HOPE dummy is a reasonably good approximation for HOPE receipt. We also considered an event-style analysis by replacing the post-hope dummy with three dummies for matriculation year. Results, reported in Appendix Table A, are qualitatively similar to using the simple post-HOPE dummy.

who obtained a 4-year degree. Sjoquist and Winters (2012b) use the same preferred specification and confirm that there was no significant effect on degree completion in our USG dataset.

III. Empirical Results

III.A. *Initial STEM Major*

We consider both initial majors and earned majors. Columns 1-4 of Table 2 presents the results for the USG analysis in which the dependent variable is whether a student initially declared a STEM major as a freshman. The first column includes dummies for sex, race, Hispanic origin, and high school attended, but not SAT, high school GPA, or institution. The second column adds SAT dummies, the third adds high school GPA dummies, and the fourth adds dummies for initial USG institution attended. There are important caveats for the last two columns. Sjoquist and Winters (2012a) argue that HOPE caused high school grade inflation for post-HOPE cohorts in Georgia. Inflated high school GPAs for post-HOPE students mean that one should be cautious interpreting results that control for high school GPA because looking at students with the same GPA compares lower quality post-HOPE students to higher quality pre-HOPE students.[3] Since student quality is positively correlated with the probability of majoring in a STEM field, grade inflation will create a negative bias in θ when controlling for high school GPA. Furthermore, HOPE likely changed which institution students attend and this may affect their majors. Our primary interest is in the overall effects of HOPE, but controlling for HOPE-induced changes in institution may partial out some of the effect. Our preferred estimates, therefore, do not control for high school GPA or institution, but we also report results that do.

[3] Castleman (2012) also finds that students in Florida take strategic actions to help ensure that their high school GPAs and SAT/ACT scores are above the cutoffs.

SAT score increases are likely to represent actual increases in student quality and should be controlled for, so our preferred specification is the second column that includes all of the controls except for high school GPA and institution.[4]

The results in the first column suggest that the HOPE Scholarship program increased the probability of declaring a STEM major as a freshman. The second column in which we control for student quality by adding the SAT score dummies results in a very small negative coefficient that is statistically insignificant. When we add the high school GPA dummies in the third column, the coefficient estimates increase in magnitude (i.e., become larger negatively) and become statistically significant. Adding institution dummies (column 4) turns the coefficient positive, and though relatively small it is statistically significantly. However, there are only 4 cohorts so the clustered standard errors should be interpreted with caution. The Conley-Taber procedure is not feasible since we have administrative data for only one state. The results for our preferred specification in column 2 suggest that controlling for changes in student quality using SAT scores HOPE had no meaningful effect on the likelihood that freshmen declared a STEM major.[5]

III.B. *Earned STEM Major*

Columns 5-8 of Table 2 report the effects of HOPE on the probability of earning a bachelor's degree in a STEM field. The coefficient on the post-HOPE dummy is statistically insignificant in column 5, but the effect is significantly negative for all regressions in columns 6-

[4] Note that the SAT is not part of the HOPE eligibility condition and thus not subject to merit-induced strategic manipulation.

[5] One limitation of the analysis using the initial major is that a very large percentage of students, almost 40 percent, do not have a declared major. This is much larger than the 19.9 percent reported by Stater (2011) for the three universities in Colorado, Indiana, and Oregon (1994-1996) and 29.5 percent reported by Carruthers and Özek (2012) for 4-year schools in Tennessee.

8. For our preferred regression in column 6, the coefficient of -0.0253 implies that HOPE reduced the number of STEM graduates by 12.9 percent. Controlling for high school GPA again decreases the coefficient. Controlling for institution again makes the coefficient smaller (i.e., less negative).[6]

While our preferred results do not control for institution (or high school GPA), the change in the coefficients from doing so offers important insights into why HOPE decreased STEM degrees. The increased coefficient on post-HOPE when controlling for institution could be due to differences across colleges in the effect of HOPE on STEM majors; for example, it could be that maintaining a 3.0 GPA could be easier at some colleges so that fewer students shift to other majors in order to maintain the HOPE Scholarship or that some colleges provide more intensive advising, which increases the attachment to the field for initial STEM majors, so that fewer students switch major as a result of HOPE. But the effect could also be due to changes in the pattern of colleges attended. HOPE enticed many of the state's "best and brightest" high school graduates to stay in-state (Dynarski 2000), which appears to have increased admission standards at institutions like the Georgia Institute of Technology (Georgia Tech).[7] This could have led to increased competition for grades or increased demands that faculty place on students in courses, leading to reduced STEM majors. HOPE-induced increased competitiveness appears

[6] Another possible control group would be non-resident USG students. However, non-residents are an imperfect control group since HOPE could have created a variety of spillover effects onto non-residents, including changes in the composition of such students. Nevertheless, it is interesting that there was a substantial increase in the percentage of all USG non-resident students who earned a STEM major (44.9 percent pre-HOPE to 49.8 percent post-HOPE), as well as a similar increase in just the research institutions (57.4 percent pre-HOPE to 62.0 percent post-HOPE).

[7] Cornwell and Mustard (2006) note that over the period 1990 to 2003 average SAT scores for Georgia college freshmen increase significantly more than the average for either U.S. or Georgia high school seniors. Average SAT math scores for in-state students increased between our pre and post-HOPE periods by 24 points at Georgia Tech and by 29 points at the University of Georgia, but by only 5 points for all other schools. The share of USG students with high SAT math scores that enrolled at Georgia Tech decreased over the period; 29.3 percent of students with SAT math scores between 600 and 800 attended Georgia Tech in the pre-HOPE period, but only 22.2 percent in the post-HOPE period. One indication of the increased admission standards at Georgia Tech is that the freshman acceptance rate fell from 69 percent in 1990 to 56 percent in 1996 (Office of Institutional Research and Planning 1990, 1996).

to have pushed more moderate ability students out to institutions at which majoring in STEM is less appealing, perhaps because these schools do not offer engineering majors or have weaker science programs. Alternatively, moderate ability students may have expected to be unable to keep a 3.0 GPA at Georgia Tech and decided to enroll at less competitive institutions to increase their chances of keeping the HOPE Scholarship. However, because other institutions are not as heavily focused on STEM fields as is Georgia Tech, students shifting away from Georgia Tech are also more likely to shift away from STEM majors. (See Section V.D for analysis by type of college.)

The pattern of coefficients by sex is also of interest. The coefficient for males is considerably larger than that for females and the difference is statistically significant in columns 6-8. In column 6 the coefficient for males is -0.0416, while the coefficient for females is only -0.0121. The larger decrease for men is partially attributable to their higher prevalence in STEM fields, but the relative magnitude for men is even greater than would be expected based on relative means. We also explored the effect of HOPE on subfields within STEM and found that the results reported above are not being driven by a particular subfield.

III.C. *Changing Majors*

Our preferred specification in Table 2 suggests that the HOPE Scholarship did not affect the initial choice of a STEM major, but did negatively affect the probability of earning a STEM degree. We explore the relationship between the initial major and the earned major, considering just two categories of majors, STEM and non-STEM. The upper panel of Table 3 is a simple crosstab between initial major and earned major, while the second panel shows for each of the two initial majors the fraction of students with earned degrees with STEM and non-STEM majors. (Table 3 considers only students who earned a college degree.) Note that 13.7 percent of students with an undeclared initial major earned a STEM degree, while only 8.4 percent of students who declared a non-STEM major as a freshman earned a degree with a STEM major. In other words, few students switched into a STEM major during their college career. On the other hand, 57.4 percent of students with an initial STEM major actually earned a STEM degree, so that 42.6 percent of freshmen STEM majors switched to another major before they graduated.[8]

Given this pattern it is of interest to consider the effect of the HOPE Scholarship on the student's earned major given the student's initial major (Table 4). Column 1 of Table 4 reproduces column 6 from Table 2, and is presented for convenience. Column 2 considers students who declared a STEM major as a freshman. The results imply, as we would expect, that the HOPE Scholarship caused a reduction in the percentage of initial STEM majors who earned a degree in a STEM field. The coefficients are statistically significant for the entire sample as well as for females and males. The magnitude of the effect of the HOPE Scholarship is larger for initial STEM majors than for the entire sample (column 1), and is larger for males than females.

Columns 3 and 4 examine the effects of HOPE on earning a STEM degree for students with an initial non-STEM major and with an initial undeclared major. For these two groups, the coefficient estimates are negative for the total population as well as for females and males separately, but the coefficients are much smaller in magnitude than for initial STEM majors and they are not statistically significant. Thus, the negative effect of HOPE on STEM degree production is primarily driven by initial STEM majors deciding not to complete degrees in STEM fields. HOPE is somehow causing additional initial STEM majors to switch away from STEM at some point before they graduate.

[8] See Stinebrickner and Stinebrickner (forthcoming) for an analysis of the attrition of STEM majors. They focus on the effect of changes in students' beliefs about their likely grade point average as STEM majors as the students take STEM courses.

III.D. *Type of College*

The University System consists of both 2-year and 4-year schools. One might expect that the effect of merit aid would differ between 2-year and 4-year colleges, perhaps because of differences in the type of students who enroll in the two types of schools, so we consider 2-year and 4-year colleges separately. Similarly, there are three large research universities, Georgia Institute of Technology, Georgia State University, and the University of Georgia. Given that the culture and other characteristics of large research universities might differ from smaller 4-year colleges, we explore whether there are differences in the effect of HOPE on STEM majors between 4-year non-research colleges and the three research universities. In addition, the Georgia Institute of Technology is the primary engineering school in the University System of Georgia; Georgia Tech accounted for 32.6 percent of STEM degrees in the sample. Given the difference in the environment in an engineering college, we consider the effect of HOPE on STEM majors at Georgia Tech. We assign the student to the school at which they initially enrolled and use the control variables in our preferred specification.

Table 5 considers the effect of HOPE on the probability of earning a STEM degree by type of school. The results for all schools and for just 4-year schools are very similar, and in particular the effect of HOPE is negative. For 4-year non-research schools, the three research universities and for Georgia Tech, the coefficients for HOPE for all students and for males are negative and statistically significant, but the magnitude of the effect is much larger for Georgia Tech and somewhat larger for the research universities than for the 4-year non-research schools. The coefficient for females is statistically insignificant in column 3, but negative and statistically significant in columns 4 and 5. It thus appears that the effect of HOPE on the probability of being a STEM major is greater at research universities and technology schools in particular.[9]

III.E. *STEM Persistence by SAT and GPA*

There is a substantial literature that attempts to explain the choice of a STEM major and the lack of persistence in earning a degree with a STEM major. The research reports that students with stronger academic ability as measured, for example, by SAT scores or initial grades in STEM courses, are more likely to initially major in a STEM field and to persist (Ost [2010]; Rask [2010]). Here we consider the effect of HOPE on earned STEM degrees for initial STEM majors by SAT math score and by college GPA using our preferred specification. We measure GPA after one year of college (that is, after 45 quarter credit hours).

Table 6 presents the results by SAT math score[10]; for each panel, the first row is the coefficient on the post-HOPE dummy, the second row in parentheses is the standard error, the third row in brackets is the fraction of students in the SAT category with an initial STEM major who earn a STEM degree in the pre-HOPE period[11], and the fourth row in braces is the implied percentage change in STEM degrees, that is, row one divided by row three. The coefficients on the post-HOPE dummy are generally negative and are statistically significant for higher SAT math scores. HOPE reduced the probability that an initial STEM major would have an earned STEM degree, and the percentage of initial STEM major students who fail to get a STEM degree due to HOPE is smaller for higher SAT score students. This is not unexpected given existing

[9] This is even despite the evidence presented above that Georgia Tech increased admission standards and is consistent with arguments that Georgia Tech may have increased grading standards in STEM fields.
[10] A few individuals do not have SAT scores. Examination of their GPAs shows that they are on average low performing students, so we include them in the lowest SAT group.
[11] Though not the focus of our study, the simple means are consistent with previous literature suggesting that STEM persistence rates increase with student ability and are generally lower for women than men.

research that finds that students with higher SAT scores are more likely to initially major in STEM and are more likely to persist and earn a STEM degree. Thus, we expect these students to be less influenced by HOPE. However, while we observe the same pattern for males, for females the relationship is reversed, with the larger percentage change being for females with high SAT math scores.[12] It should be of concern for policymakers that HOPE appears to reduce the probability of earning a STEM degree even for students with high SAT math scores.

The results by first-year GPA (for initial STEM majors) are presented in Table 7, which parallels the format of Table 6. The coefficients are negative, with one exception, but less than half are statistically significant. There is no consistent pattern in the size of the coefficients on HOPE or the percentage change in the number of students who fail to earn a STEM degree because of HOPE. The results suggest that the HOPE Scholarship reduced the probability of an earned STEM major regardless of first-year GPA, and that in general the magnitude of the effect does not depend on the first-year GPA. Cornwell, Lee, and Mustard (2005, 2008) suggest that the requirement that students maintain a 3.0 GPA in order to retain eligibility for a HOPE Scholarship causes students to engage in strategic behavior, such as taking lighter course loads and changing majors if the student is close to a 3.0 GPA. We do not find a larger effect of HOPE for students with a first-year GPA near 3.0, but some students may have already changed majors and others may have padded their first year schedule with easier courses. As Ost (2010) reports, grades both push students away from a major and pull them towards a major, and since first year grades are not necessarily in STEM courses, the effect by grade may reflect the pull of grades into non-STEM fields.

[12] The large magnitude for females with high SAT math scores was not expected. One possible explanation is that this effect could be caused by an increase in female students at Georgia Tech, which as Table 5 shows had a larger effect on STEM majors. However, the increase in the percentage of female students at Georgia Tech pre- and post-HOPE was no larger than that experienced in the rest of the USG. Furthermore, the number of females with 700 or better SAT-Math scores is relatively small, so the coefficient is not precisely estimated.

A further difficulty with using first year GPAs is that it appears that HOPE led to an increase in grades. Table 8 explores how the post-HOPE dummy affected students' first year GPAs, by category of majors. In general, the results imply that the HOPE Scholarship program increased students' GPAs, but the effects for initial STEM majors who earn STEM degrees are smaller than the effects for initial STEM majors earning degrees in other fields. This suggests that many of the latter group may have already begun taking a non-STEM curriculum. These results are consistent with the suggestion that students take action to improve their grades in an attempt to meet HOPE's 3.0 GPA renewal requirement. Because college GPA is subject to various forms of manipulation, it cannot be viewed as an exogenous measure of student ability for our analysis.

III.F. *Non-STEM Majors*

Table 9 considers the effect of HOPE on earned non-STEM majors; the upper panel considers all students while the lower panel considers just initial STEM majors. For the full sample, HOPE appears to cause an increase in the probability of majoring in business and in health and a decrease in education and social science majors. The coefficient on the post-HOPE dummy for liberal arts majors is positive but statistically insignificant. There are differences in the pattern by gender. The large shift toward business is somewhat surprising given mechanisms suggested by Stater (2011) and Rothstein and Rouse (2011) that financial aid is expected to shift students away from high paying majors like business.

The bottom panel of Table 9 contains results using just those students who declared a STEM major as a freshman. Table 9 suggests that initial STEM majors who changed major shifted into business and liberal arts, although there are differences in the patterns by gender.

Cornwell, Lee and Mustard (2008), using data from the University of Georgia, find that HOPE led to an increase in the probability of an initial education major. This leads to an expectation that merit-aid programs would also increase the probability of an earned major in education, but we find that merit aid reduces the probability of an earned major in education. To explore this conflict in results, we redid our analysis using just data for the University of Georgia and find that HOPE had no effect on the probability of an earned major in education. Cornwell, Lee, and Mustard (2008), however, consider only initial major. When we consider the initial major for University of Georgia students, we obtain a positive, but statistically insignificant, coefficient on HOPE that is similar in magnitude to that found by Cornwell, Lee, and Mustard. Thus, there may have been a slight positive effect of HOPE on initial education majors for students at the University of Georgia, but there appears to be no effect of HOPE on education degrees conferred.

IV. Summary and Conclusions

State merit aid programs have grown significantly since the early 1990s, but these programs could have unintended effects that harm the economic interests of the state and the nation. In particular, merit programs may inadvertently cause students to choose different college majors than they would have in the absence of merit aid. The U.S. has experienced increasing concern that the nation is producing too few graduates with degrees in science, technology, engineering, and mathematics (STEM) fields. STEM graduates play an important role in creating new technologies that lead to new production processes and increased productivity, and thus producing too few STEM graduates could have very harmful economic effects for the nation and individual states.

This paper uses student records from the University System of Georgia (USG) to examine whether Georgia's HOPE Scholarship program altered students' college major decisions. We focus on the effects on STEM fields but also examine the effects on other majors. We find significant evidence that HOPE reduced the likelihood that a young person earned a degree in a STEM field. Our baseline specification gives a coefficient of -0.025, which corresponds to a 12.9 percent decrease in the number of STEM graduates. We find that although Georgia's HOPE Scholarship reduced STEM degree completion, it did not affect the likelihood that a student chose STEM as their initial major. Instead, HOPE appears to have caused some students to change majors out of STEM fields at some point in their college career. Furthermore, the decrease in STEM degrees was driven largely by the decrease in initial STEM majors actually earning a STEM degree (not by fewer students switching into a STEM field) and by the decrease in earned STEM degrees by students enrolled at the state's research universities. The decrease in STEM degrees also occurred throughout the ability distribution, but the relative effects were most pronounced for students with good but unexceptional math skills.

Our finding that HOPE reduces the probability of earning a STEM degree could be consistent with a number of possible mechanisms. We are unable to say conclusively which mechanisms are driving the results, but we do offer some insights. First, Stater (2011) argues that an increase in financial aid lowers the price of majors that offer current consumption benefits and encourages student substitution toward such majors. Similarly, financial aid could be viewed as a transitory income shock that could lead to more current consumption oriented majors.[13] Rothstein and Rouse (2011) suggest that student loan debt might affect a student's

[13] Riegle-Crumb et al. (2012), using the NELS and HS&B, find that an additional $10,000 of real family income reduces the probability that a student will declare a physical science/engineering major by 0.2 to 0.5 percentage points. However, $10,000 of permanent family income might have very different effects than transitory income from student financial aid.

choice of college major and future occupation due to debt aversion and credit constraints. Students who are debt averse may choose high earning majors and occupations to pay off debt quickly after graduation. Post-graduation credit constraints may make it difficult to finance large purchases like cars and houses, and individuals may pursue high earning majors and occupations to make these more attainable. Financial aid should decrease student loan debt and may reduce the importance of future earnings in college major decisions.

Cornwell, Lee, and Mustard (2008) suggest that the requirement that students maintain a 3.0 GPA to retain the Georgia HOPE Scholarship could encourage students to major in subjects for which it is easier to maintain the required GPA.[14] Similarly, high school GPA eligibility requirements for merit scholarships may provide incentives for students to take easier courses in high school, which could make them less prepared for more challenging majors in college; alternatively, if merit programs increase student effort in high school, they could cause students to be better prepared for college, which is consistent with the findings of Henry and Rubenstein (2002) and Heller and Rogers (2003).

Previous researchers (Dynarski 2000; Cornwell, Mustard, and Sridhar 2006) find that merit programs increase the likelihood that students stay in-state to attend college and affect the type of in-state institution they attend, which could alter the college major options that are available and alter the relative attractiveness of various majors. In particular, merit programs increase the percentage of high ability students who stay in-state, which may make it harder for more moderate ability students to obtain admission to the most selective institutions in the state, which could affect these students' choice of major. Furthermore, if grading is done on a relative basis, merit-induced grade competition from better students may cause moderate ability students

[14] Dee and Jackson (1999) find that students in science, engineering, and computing are substantially more likely to lose the Georgia HOPE scholarship than students in other disciplines, but they do not consider the effects that this might have on students' major choices.

to earn lower grades in difficult majors and encourage them to switch to easier majors to stay in college.[15] Similarly, institutions experiencing increased enrollment due to merit aid may raise standards in STEM fields to push lower ability students into other majors with lower instructional costs.

STEM degrees pay relatively high salaries and the mechanisms posited by Stater (2011) and Rothstein and Rouse (2011) suggest that financial aid causes students to shift away from high paying majors, though it is unclear how large the expected effects should be. However, business majors also have relatively high salaries and we do not see a shift away from business; we actually see a strong shift toward business. Additionally, the Stater (2011) and Rothstein and Rouse (2011) mechanisms would suggest a decrease in initial STEM majors, but we observe no such decrease. So while we cannot rule out the Stater (2011) and Rothstein and Rouse (2011) mechanisms, they seem unlikely to be the primary explanations for the relatively large decrease in STEM degrees that we find.

Our analysis provides support for two other mechanisms. First, the results suggest that HOPE induced students of a given academic ability to enroll in institutions that make them less likely to earn a STEM degree. This appears to have resulted in part from merit-induced increased selectivity at top universities like Georgia Tech, which pushed out many moderate ability students. However, changes in students' college enrollment decisions could also be driven by another mechanism: students have incentives to alter their education plans in order to keep a 3.0 GPA to retain the HOPE Scholarship. This could motivate some students to attend less challenging institutions and major in less challenging fields. We find that HOPE caused first-year GPAs to increase, which is consistent with students taking actions to improve their

[15] Luppino and Sander (2012) and Arcidiacono, Aucejo, and Hotz (2013) report evidence of peer effects using data from the University of California system. Attending a UC campus where the sciences are more competitive makes a moderate ability student less likely to earn a science degree.

grades to try to meet HOPE's 3.0 GPA renewal requirement. These actions likely included changing majors away from STEM fields because STEM fields are on average more difficult than other majors.

Without knowing more about the mechanism through which merit aid affects the choice of major it is hard to provide firm policy recommendations short of eliminating merit aid. If concern with obtaining the GPA necessary to maintain eligibility is the mechanism, there are possible changes that could be made. The GPA used to determine continuing eligibility could be based on courses that are not related to the major, or the GPA could be based on courses taken beginning in the second year. If high school students avoid taking courses that prepare them to be STEM majors in order to become merit aid eligible, allowing merit aid eligibility to be based on SAT or ACT score could reduce that disincentive.

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Table 1: Summary Statistics for USG Data

	All Graduates		Females		Males	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
STEM Major	0.197	0.398	0.128	0.334	0.289	0.453
Business Major	0.261	0.439	0.213	0.410	0.324	0.468
Education Major	0.153	0.360	0.216	0.412	0.068	0.252
Health Major	0.057	0.232	0.090	0.286	0.013	0.114
Liberal Arts Major	0.157	0.364	0.155	0.362	0.160	0.367
Social Science Major	0.175	0.380	0.198	0.398	0.145	0.352
Post-HOPE Dummy	0.540	0.498	0.554	0.497	0.521	0.500
SAT Math	518.4	92.8	498.9	85.8	544.3	95.4
SAT Verbal	520.7	90.0	513.0	88.5	530.9	91.0
High School GPA	3.037	0.620	3.092	0.600	2.963	0.639
Female	0.572	0.495	1.000	0.000	0.000	0.000
Black	0.182	0.386	0.224	0.417	0.126	0.332
Hispanic	0.010	0.102	0.010	0.099	0.011	0.105
Asian	0.029	0.167	0.026	0.159	0.033	0.177
Native American	0.002	0.039	0.001	0.038	0.002	0.040
Observations	42,399		24,263		18,136	

Table 2: Effects of HOPE on Choosing a STEM Major

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Initial Major				Earned Major			
A. Total	0.0231	-0.0048	-0.0201	0.0086	-0.0058	-0.0253	-0.0384	-0.0216
	(0.0080)*	(0.0059)	(0.0042)**	(0.0013)***	(0.0065)	(0.0033)***	(0.0041)***	(0.0029)***
B. Females	0.0284	0.0074	-0.0046	0.0121	0.0041	-0.0121	-0.0240	-0.0128
	(0.0043)***	(0.0051)	(0.0038)	(0.0033)**	(0.0050)	(0.0048)*	(0.0049)**	(0.0023)**
C. Males	0.0181	-0.0182	-0.0343	0.0065	-0.0180	-0.0416	-0.0538	-0.0321
	(0.0162)	(0.0086)	(0.0075)**	(0.0024)*	(0.0096)	(0.0025)***	(0.0029)***	(0.0039)***
Sex, Race/Ethnicity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SAT Dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes
High School GPA Dummies	No	No	Yes	Yes	No	No	Yes	Yes
USG Institution Dummies	No	No	No	Yes	No	No	No	Yes

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 3: Share of USG Graduates by Initial Major and Degree Major

		Initial Major			
		Undeclared	Non-STEM	STEM	Total
Degree	Non-STEM	0.342	0.381	0.080	0.803
Major	STEM	0.054	0.035	0.108	0.197
	Total	0.397	0.416	0.188	1.000
Degree	Non-STEM	0.863	0.916	0.426	
Major	STEM	0.137	0.084	0.574	
	Total	1.000	1.000	1.000	

Note that Initial Major is the major the student declared as a freshman, while Degree Major is the major that the student graduated with. The table includes only students who completed college. The upper panel shows the distribution across all graduates, while the second panel shows the allocation across Degree Major for each Initial Major.

Table 4: Effects of HOPE on Earning a STEM Degree by Initial Major

	(1) Full Sample	(2) Initial STEM Majors	(3) Initial Non-STEM Majors	(4) Initial Undeclared Majors
A. Total	-0.0253	-0.0788	-0.0098	-0.0085
	(0.0033)***	(0.0151)**	(0.0075)	(0.0044)
B. Females	-0.0121	-0.0633	-0.0081	-0.0053
	(0.0048)*	(0.0163)**	(0.0040)	(0.0047)
C. Males	-0.0416	-0.0937	-0.0110	-0.0138
	(0.0025)***	(0.0252)**	(0.0162)	(0.0062)
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No
USG Institution Dummies	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 5: Effects of HOPE on Earning a STEM Degree by Students' Initial Institutions

	(1)	(2)	(3)	(4)	(5)
	Full USG	4-Year Schools	4-Year Non-Research	Research Universities	Georgia Tech
A. Total	-0.0253	-0.0284	-0.0121	-0.0588	-0.0944
	(0.0033)***	(0.0036)***	(0.0033)**	(0.0084)***	(0.0152)***
B. Females	-0.0121	-0.0145	0.0015	-0.0442	-0.1468
	(0.0048)*	(0.0048)*	(0.0026)	(0.0093)**	(0.0045)***
C. Males	-0.0416	-0.0455	-0.0331	-0.0679	-0.0762
	(0.0025)***	(0.0027)***	(0.0061)**	(0.0096)***	(0.0171)**
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 6: Effects of HOPE on Earning a STEM Degree by SAT Math Score for Initial STEM Majors

	(1)	(2)	(3)	(4)	(5)
SAT Math	<400	400-499	500-599	600-699	700-800
A. Total	-0.0295	-0.0052	-0.0678	-0.0805	-0.0585
	(0.0280)	(0.0176)	(0.0141)**	(0.0238)**	(0.0168)**
	[0.3438]	[0.3680]	[0.5539]	[0.7307]	[0.9020]
	{-8.57%}	{-1.41%}	{-12.24%}	{-11.02%}	{-6.49%}
B. Females	0.0157	0.0262	-0.0321	-0.0594	-0.1134
	(0.1091)	(0.0312)	(0.0056)**	(0.0234)*	(0.0588)
	[0.2987]	[0.2829]	[0.4571]	[0.6685]	[0.9608]
	{5.24%}	{9.26%}	{-7.02%}	{-8.89%}	{-11.80%}
C. Males	-0.0128	-0.0691	-0.1169	-0.0824	-0.0409
	(0.1790)	(0.0621)	(0.0278)**	(0.0318)*	(0.0240)
	[0.4118]	[0.4786]	[0.6324]	[0.7588]	[0.8902]
	{-3.11%}	{-14.44%}	{-18.49%}	{-10.86%}	{-4.59%}
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 7: Effects of HOPE on Earning a STEM Degree by First-Year GPA for Initial STEM Majors

	(1)	(2)	(3)	(4)	(5)	(6)
Freshman GPA	<2.50	2.50-2.79	2.80-2.99	3.00-3.19	3.20-3.49	3.50-4.00
A. Total	-0.0718	-0.1449	-0.0632	-0.0878	-0.0321	-0.1027
	(0.0322)	(0.0281)**	(0.0563)	(0.0131)***	(0.0143)	(0.0139)***
	[0.4869]	[0.6327]	[0.6311]	[0.6695]	[0.7177]	[0.8088]
	{-14.75%}	{-22.90%}	{-10.01%}	{-13.11%}	{-4.47%}	{-12.70%}
B. Females	-0.0394	-0.1306	-0.1085	-0.1629	0.0411	-0.0704
	(0.0456)	(0.0820)	(0.0826)	(0.0726)	(0.0417)	(0.0141)**
	[0.3559]	[0.4656]	[0.5278]	[0.5577]	[0.5724]	[0.7238]
	{-11.07%}	{-28.05%}	{-20.56%}	{-29.21%}	{7.18%}	{-9.73%}
C. Males	-0.0858	-0.1356	-0.0483	-0.0950	-0.1114	-0.1247
	(0.0404)	(0.0568)*	(0.0658)	(0.0148)***	(0.0308)**	(0.0248)**
	[0.5695]	[0.7310]	[0.7132]	[0.7576]	[0.8106]	[0.8650]
	{-15.07%}	{-18.55%}	{-6.77%}	{-12.54%}	{-13.74%}	{-14.42%}
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 8: Effects of HOPE on First-Year GPA

	(1) All Graduates	(2) Initial STEM Majors	(3) Initial STEM Majors Earning STEM Degrees	(4) Initial STEM Majors Earning Non-STEM Degrees
A. Total	0.1793	0.1290	0.1229	0.1847
	(0.0119)***	(0.0120)***	(0.0201)***	(0.0106)***
B. Females	0.1928	0.1467	0.1533	0.1672
	(0.0118)***	(0.0247)***	(0.0345)**	(0.0465)**
C. Males	0.1604	0.1074	0.0998	0.1823
	(0.0146)***	(0.0129)***	(0.0272)**	(0.0274)***
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No
USG Institution Dummies	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year.
*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 9: HOPE Program Effects on Non-STEM Earned Majors

	(1) Business	(2) Education	(3) Health	(4) Liberal Arts	(5) Social Sciences
Full Sample:					
A. Total	0.0494	-0.0282	0.0045	0.0101	-0.0105
	(0.0025)***	(0.0037)***	(0.0017)*	(0.0052)	(0.0032)**
B. Females	0.0238	-0.0417	0.0094	0.0163	0.0042
	(0.0043)**	(0.0052)***	(0.0022)**	(0.0040)**	(0.0014)*
C. Males	0.0797	-0.0072	-0.0013	-0.0008	-0.0288
	(0.0063)***	(0.0026)*	(0.0009)	(0.0068)	(0.0062)**
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No
Initial STEM Majors:					
A. Total	0.0579	-0.0015	0.0079	0.0121	0.0024
	(0.0138)**	(0.0043)	(0.0048)	(0.0039)*	(0.0038)
B. Females	0.0334	-0.0147	0.0134	0.0120	0.0192
	(0.0160)	(0.0071)	(0.0156)	(0.0015)***	(0.0106)
C. Males	0.0768	0.0061	0.0033	0.0099	-0.0024
	(0.0222)**	(0.0018)**	(0.0011)*	(0.0091)	(0.0030)

Standard errors in parentheses are clustered by high school graduation year.
*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table A: USG Cohort Year Dummy Coefficients

Outcome:	Initial STEM Major	STEM Degree
A. Total Population		
1991 Cohort Dummy	0.0044	0.0053
	(0.0054)	(0.0053)
1995 Cohort Dummy	-0.0084	-0.0227
	(0.0054)	(0.0053)***
1996 Cohort Dummy	0.0032	-0.0222
	(0.0053)	(0.0053)***
B. Females		
1991 Cohort Dummy	-0.0028	0.0062
	(0.0067)	(0.0062)
1995 Cohort Dummy	0.0013	-0.0091
	(0.0066)	(0.0061)
1996 Cohort Dummy	0.0102	-0.0082
	(0.0065)	(0.0061)
C. Males		
1991 Cohort Dummy	0.0130	0.0059
	(0.0088)	(0.0092)
1995 Cohort Dummy	-0.0184	-0.0381
	(0.0089)**	(0.0094)***
1996 Cohort Dummy	-0.0040	-0.0387
	(0.0089)	(0.0093)***

Note: 1990 is the omitted based year. Other specifications correspond to columns 2 and 6 of Table 2. OLS Standard errors are in parentheses. **Significant at 5%; ***Significant at 1%.